First Isomeric Quadrupole Moment Measured in Fragmentation Reactions:

the case of $^{61m}Fe(9/2^+)$

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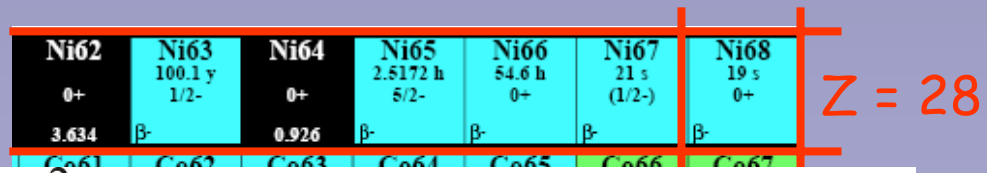
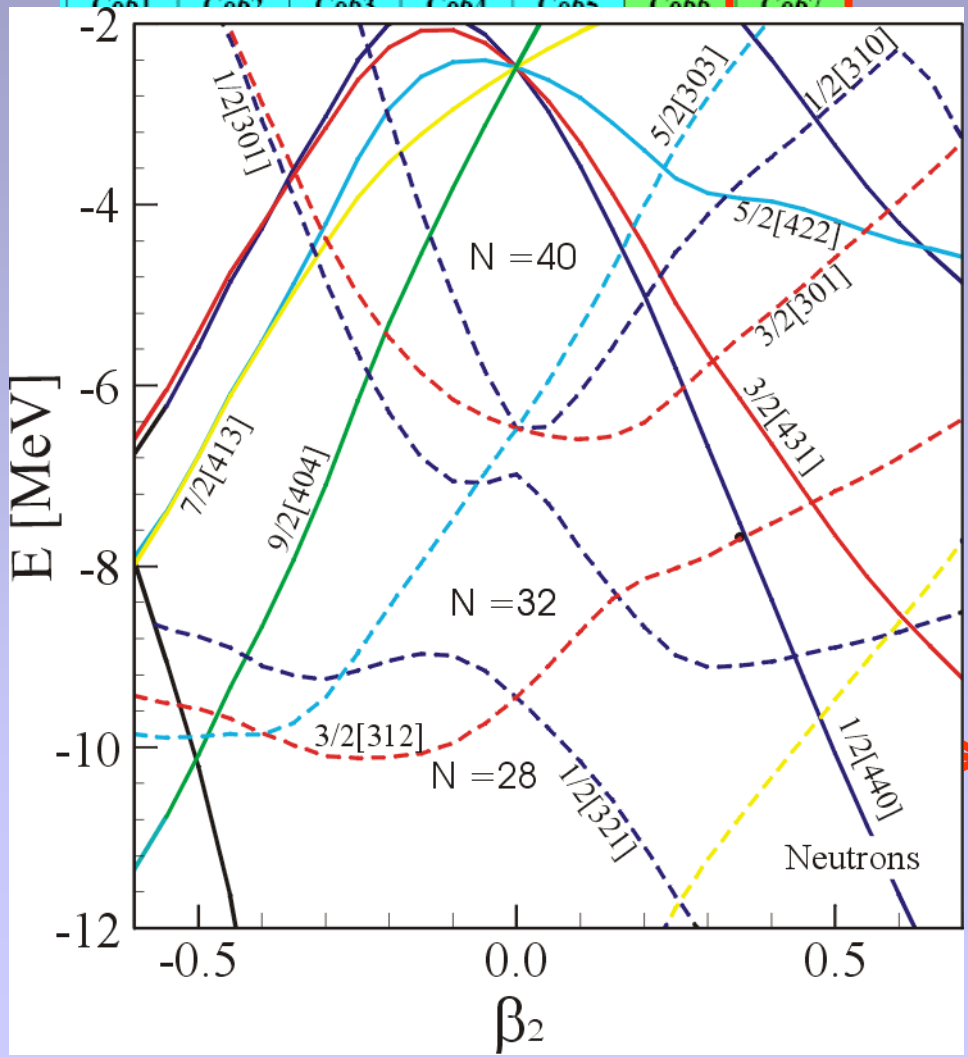
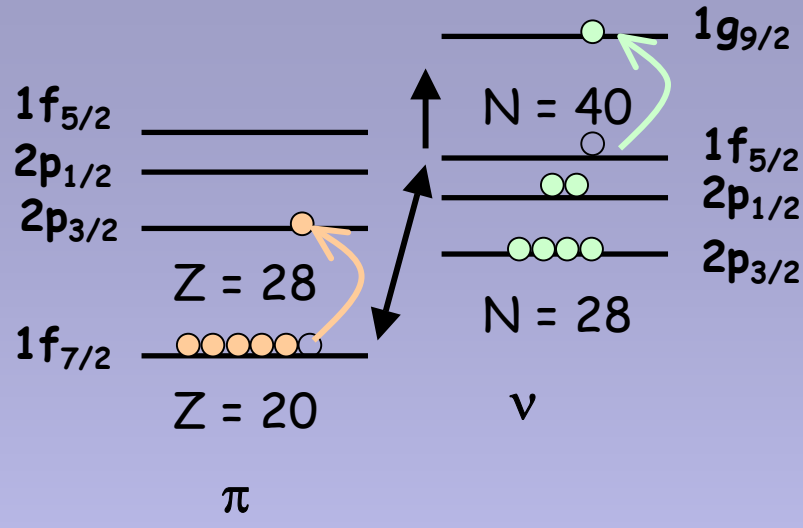
Motivation





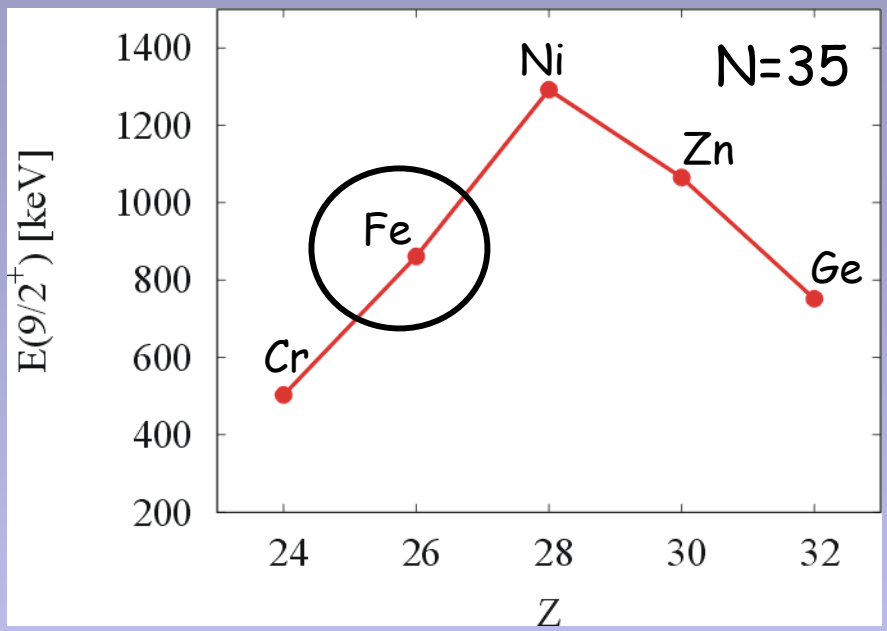


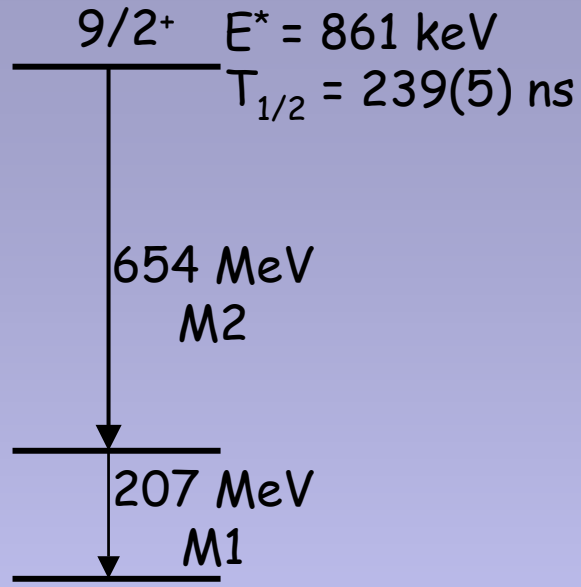
- stability of the Z=28 shell gap?
- evolution of N=40 sub-shell gap?
- the role of the $\nu g_{9/2}$ orbital?

onset of deformation

M. Hannawald *et al.*, PRL 82 (1999)
O. Sorlin *et al.*, Eu. Phys. J A 16 (2003)

Motivation





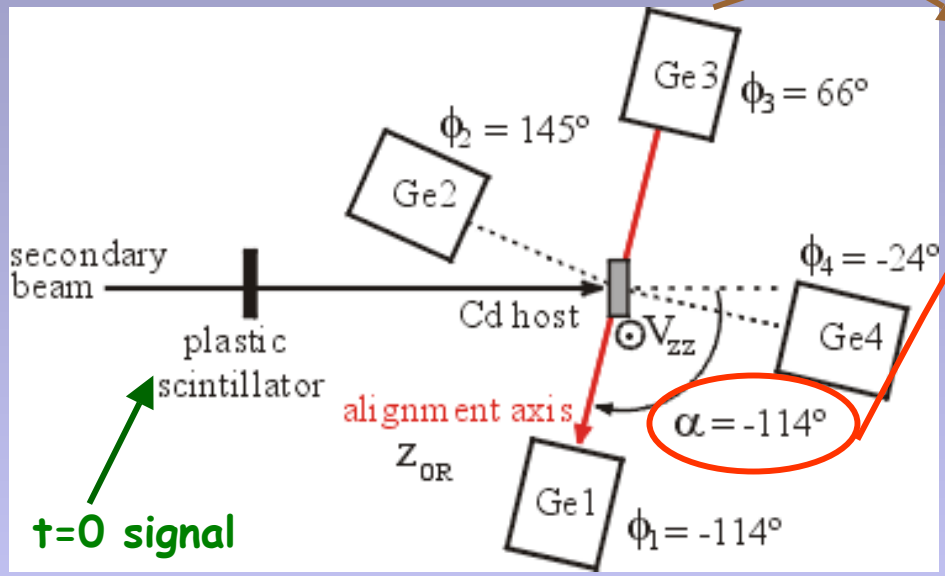
I. Matea *et al.*, PRL 93 (2004)

- $9/2^+$ assignment and decay scheme confirmed by *g* factor measurement
- comparison with LSSM calculations in fpg model space suggested a deformed structure for the $9/2^+$ isomer with Q_s= -58 efm^2

➡ Measure quadrupole moment!

Experiment - TDPAD

^{61m}Fe populated and spin-aligned in the fragmentation of a 64.6 Mev/u ^{64}Ni-beam on a ^{9}Be-target and selected with the LISE separator at GANIL



γ' s detected within 3 μs time-window after ion-arrival

rotation due to separator dipoles

→ g factor dependent experimental geometry!!

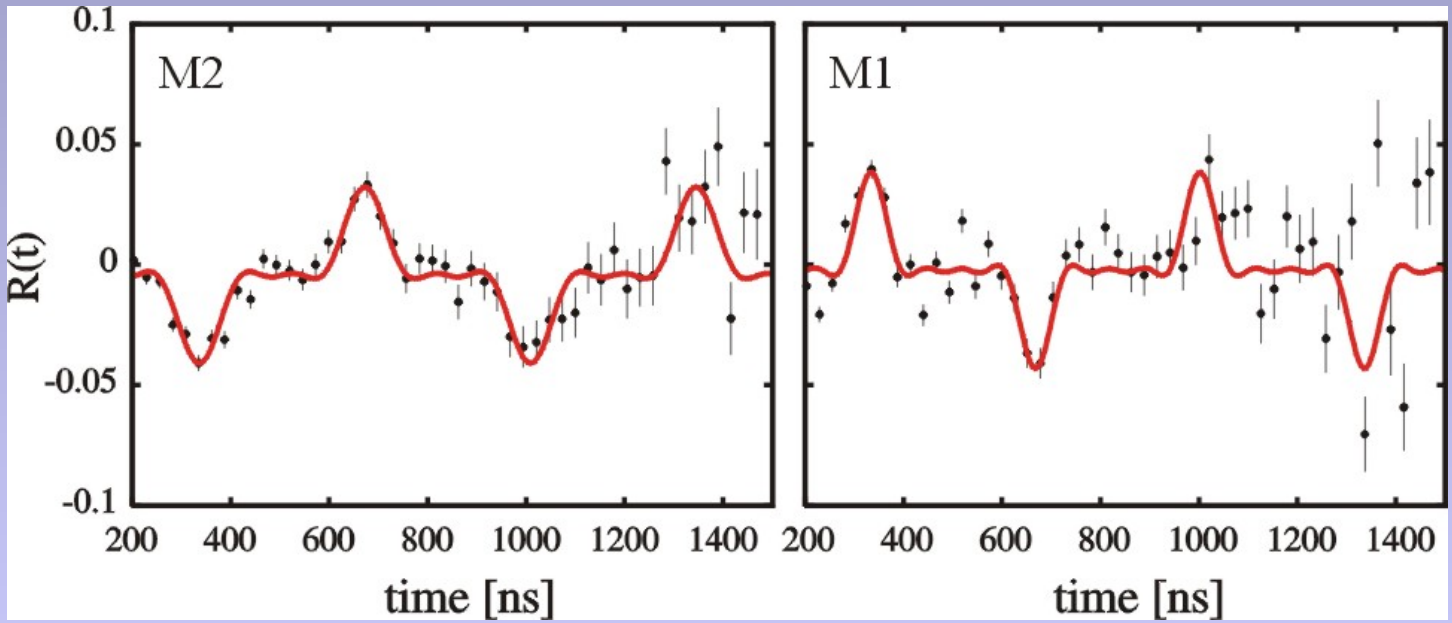
- interaction between the nuclear *Q* moment and the electric field gradient (V_{zz}) of the Cd crystal perturbs the angular distribution of the γ-rays de-exciting the isomer
- $\nu_Q = eQVzz/h$ can be extracted by monitoring the angular distribution as a function of time → **T**ime **D**ifferential **P**erturbed **A**ngular **D**istribution

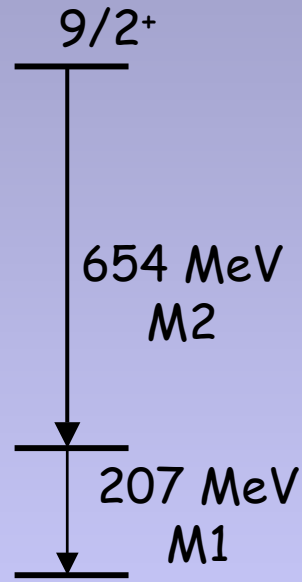
Experiment - TDPAD

- γ-ray intensity: $I_i(t)=I_0 e^{-t/\tau} \sum_{k,k'=even}^{n} A_k U_k B^0_{k'} c^n_{kk'} \cos(n\omega_0 t)$

$$\omega_0 = \frac{3\pi\upsilon_Q}{I(2I-1)}$$

- $R(t)= I_1(t)-I_2(t) / I_1(t)+I_2(t)$





$|\upsilon_Q(^{61}\mathrm{Fe},9/2^+)| = 35.7(3)$ MHZ , together with $\upsilon_Q(^{57}\mathrm{Fe},3/2^-) = 13.0(6)$ MHZ

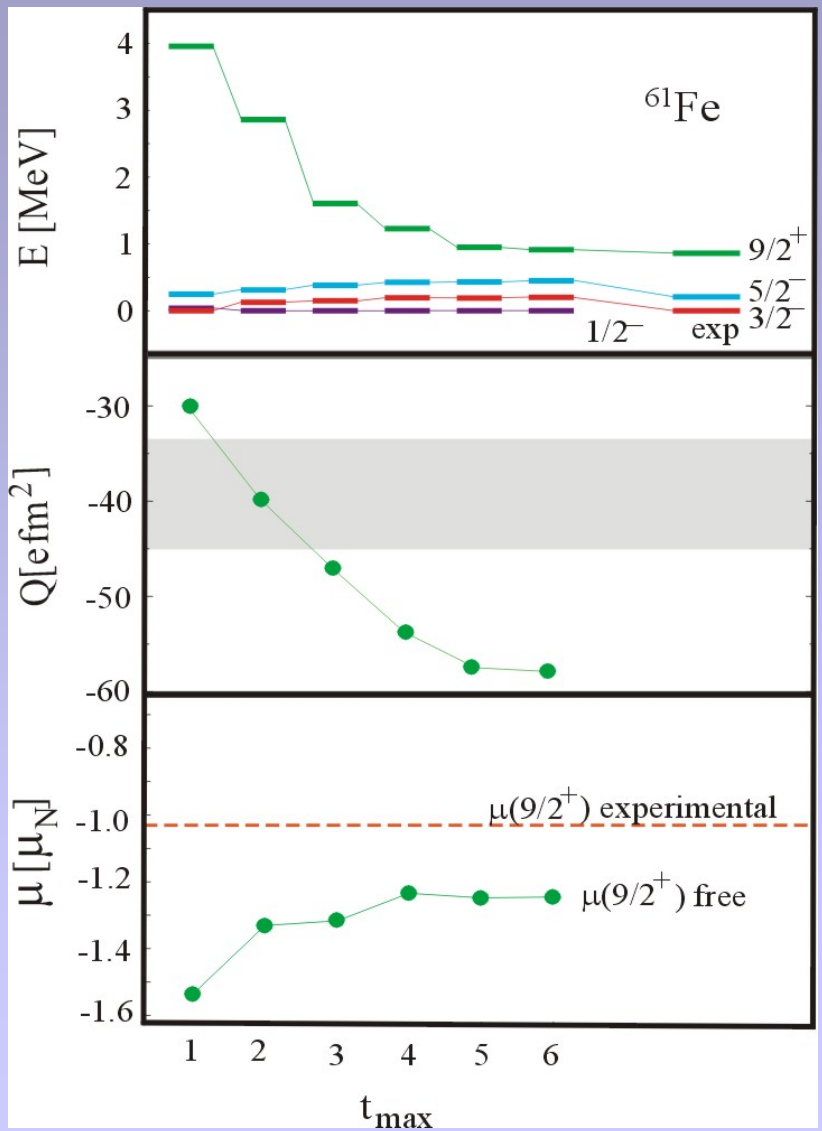
and $Q_s(^{57}\mathrm{Fe},3/2^-) = +15(2)$ efm^2 ➡ $|Q_s(^{61}\mathrm{Fe},9/2^+)| = 41(6)$ efm^2

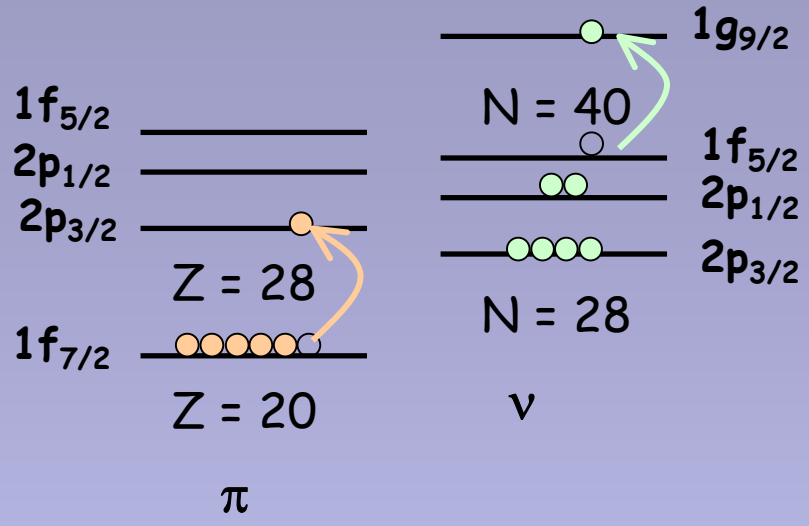
R. Vianden, Hyp. Int. 35 (1987), G. Martinez-Pinedo *et al.*, PRL 87 (2001)

LSSM calculations

ANTOINE, Caurier et al, Acta Phys. Pol. 30 (1999)

fpg interaction from O. Sorlin *et al.*, PRL 87 (2001)





- excitations across Z=28 !
- very mixed wavefunction
- mean occupancy of $\nu g9/2 \approx 1$

effective g_s, e_π, e_ν??

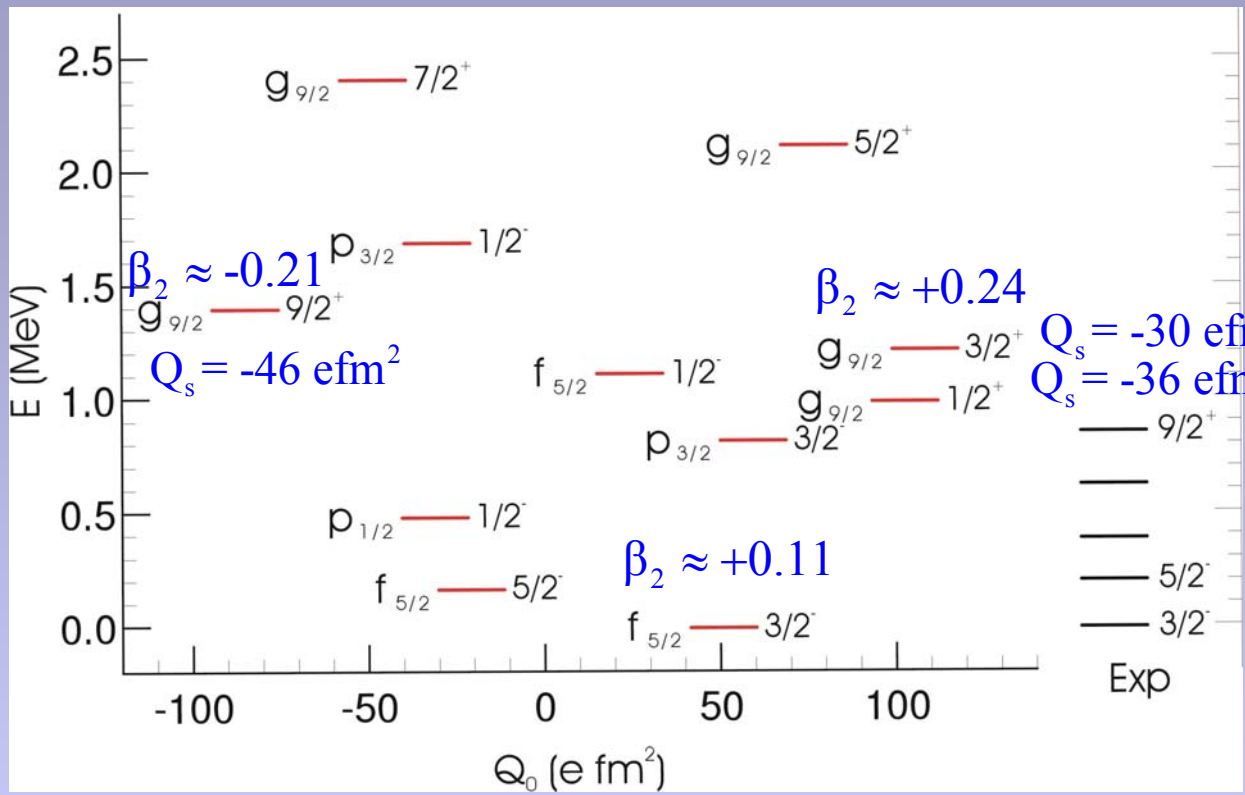
- g factors of $9/2^+$ states in ^{63}Ni and ^{65}Ni reproduced with g_s(free)

G. Georgiev et al., Eur. Phys. J A 30 (2006)

I. Matea *et al.*, PRL 93 (2004)

HFB calculations with Gogny force

GCM + GOA from Bruyères le Châtel (H. Goutte *et al.*)



- intrinsic deformation
- no effective charges!
- $9/2^+$ isomer can be prolate or oblate
- information on levels above $9/2^+$ is needed!

Collaboration

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